

CLAIMS

What is claimed is:

1 Claim 1. In an electronic device for generating user detectable multi-
2 functional feedback with a single component in response to a stimulus signal, the
3 electronic device including a housing, a display, and electronic circuitry located in the
4 housing, the improvement comprising:
5 a lens covering the display, the lens having a transparent area placed over
6 the display,
7 force sensors attached to the lens for detecting a touch against the lens, the
8 force sensors producing a stimulus signal in response to the touch,
9 at least one resonating vibrating element attached to an area of said lens
10 extending outside of the display, the at least one resonating vibrating element being
11 operable to produce at least two feedback signals selected from a group consisting of a
12 haptic feedback signal, a vibratory alert signal, an audio signal, and a buzzer signal;
13 and
14 an electrical drive circuit electrically coupled to said at least one resonating
15 vibrating element for electrically driving said at least one resonating vibrating element
16 with a drive signal based on the stimulus signal.

1 Claim 2. In an electronic device according to claim 1, said feedback
2 signals comprising at least one of a haptic feedback signal, a vibratory alert signal, an
3 audio signal and a buzzer signal.

1 Claim 3. In an electronic device according to claim 1, the electronic
2 device further comprising:
3 means for determining the resonance frequency of one of the housing and
4 the lens by producing a bursted frequency sweep;
5 means for detecting a vibration level with said force sensors; and
6 means for feeding an obtained frequency to said at least one resonating
7 vibrating element.

1 Claim 4. In an electronic device according to claim 1, said at least one
2 resonating vibrating element being operable as an acceleration sensor.

1 Claim 5. In an electronic device according to claim 1, said at least one
2 resonating vibrating element comprising a piezo-bender of one of a unimorph, a
3 bimorph and a multilayer structure.

1 Claim 6. In an electronic device according to claim 5, the electronic
2 device further comprising an external mass attached to said piezo-bender.

1 Claim 7. In an electronic device according to claim 1, wherein one of
2 the housing and said lens is manufactured so that at least one of its resonating
3 frequencies is within a frequency range of said at least one resonating vibrating
4 element.

1 Claim 8. In an electronic device according to claim 1, the electronic
2 device being a hand-held electronic device.

1 Claim 9. A dynamic user interface for generating user detectable
2 multi-functional feedback with a single component in response to a stimulus signal in a
3 device that includes a housing, a display, and electronic circuitry located in the housing,
4 the dynamic user interface comprising:
5 a lens covering the display, the lens having a transparent area placed over
6 the display,
7 force sensors attached to the lens for detecting a touch against the lens, the
8 force sensors producing a stimulus signal in response to the touch,
9 at least one resonating vibrating element attached to an area of said lens
10 extending outside of the display, the at least one resonating vibrating element being

11 operable to produce at least two feedback signals selected from a group consisting of a
12 haptic feedback signal, a vibratory alert signal, an audio signal, and a buzzer signal;
13 and
14 an electrical drive circuit (DC) electrically coupled to said at least one
15 resonating vibrating element for electrically driving said at least one resonating vibrating
16 element with a drive signal based on said stimulus signal.

1 Claim 10. The dynamic user interface according to claim 9,
2 said feedback signals comprising at least one of a haptic feedback signal, a vibratory
3 alert signal, an audio signal, and a buzzer signal.

1 Claim 11. The dynamic user interface according to claim 9, further
2 comprising:
3 means for determining a resonance frequency of one of the housing and the
4 lens by producing a bursted frequency sweep;
5 means for detecting a vibration level with said force sensors; and
6 means for feeding an obtained frequency to said at least one resonating
7 vibrating element.

1 Claim 12. The dynamic user interface according to claim 9, wherein
2 said at least one resonating vibrating element is operable as an acceleration sensor.

1 Claim 13. The dynamic user interface according to claim 9, wherein
2 said at least one resonating vibrating element comprises a piezo-bender of one of a
3 unimorph, a bimorph and a multilayer structure.

1 Claim 14. The dynamic user interface according to claim 13, wherein
2 the dynamic user interface further comprises an external mass attached to said piezo-
3 bender.

1 Claim 15. The dynamic user interface according to claim 9, wherein
2 one of the housing and said lens (TP) is manufactured so that at least one of its
3 resonating frequencies is within a frequency range of said at least one resonating
4 vibrating element.

1 Claim 16. The dynamic user interface according to claim 9, wherein the
2 device is a hand-held electronic device.